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VARIATIONS IN A COPEPOD CRUSTACEAN.

BY CARL F. GISSLER, PH.D.

IN March, 1878, a large, deep pond near Glendale, Long Island, was found densely populated with blood red Copepod Crustaceans, which, microscopically examined, proved to be a form slightly aberrant from *Diaptomus sanguineus*, described by Professor S. A. Forbes,[1] who figured its inferior and superior maxilliped and fifth pair of legs of the male and female.

The Long Island form[2] is unquestionably the same species as that from Illinois, but the climate and locality have effected slight morphological changes of those organs which in Copepod Crustaceans are most liable to occur. The differences noted between the individuals from the two localities are, however, very trifling, and its elevation to the rank of a new species would not be advisable. It appears, as in so many other instances, that careful examinations of a species from different localities do not demonstrate the constancy, but the evolution of the same. The changes sometimes concern insignificant structures, but often also the most important parts used by the systematist in describing a species.

To make the study of Copepods[3] in general, better understood to the amateur, I have more thoroughly described and figured all their external structures.

The body of Copepoda is more or less distinctly segmented and

[1] Bulletin of the Illinois Museum of Natural History. No. 1. List of Crustaceans, with descriptions of new species, by S. A. Forbes, 1876.

[2] Measures $3^{mm.}$ in length.

[3] Consult also "Die freilebenden Copepoden," by Professor Dr. C. Claus. Leipzig, 1863, page 200.

distinguishable into regions, with two pairs of antennæ, the anterior pair much larger, either one or both of the latter often transformed into an auxiliary, prehensile, copulative organ. They possess neither a carapace nor a bivalve shell; but have three pairs of mouth-parts and five pairs of swimming feet. Females with external egg-sac.

Family of Calanidæ.—Body elongate, similar to that of Pontellidæ, anterior antennæ very long, usually of twenty-four to twenty-five joints. In the male sex the right, rarely the left antenna is transformed into a geniculating, prehensile organ. Posterior antennæ comparatively large, two-branched. Mandibulary palpus two-branched, similar to the posterior antennæ. Maxillæ with a large, manifold-lobed palpus. Maxillipeds powerfully developed. Fifth pair of legs large, either similar to the four preceding or alike in both sexes, or aberrant from those and dissimilar in the sexes; in the male a clasping organ to assist, together with the right antenna, in copulation. Heart present. Eyes highly developed, median and mobile. Male genital glands unpaired, female glands paired. Single median egg-sac of orbicular shape.

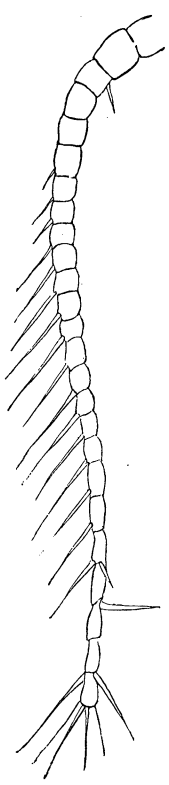

FIG. 1.—Left anterior antenna of male.

We now drop some live specimens into alcohol; they will die in a few seconds; leaving these crimson colored little Crustaceans in alcohol for some time, they will soon become pale and finally yellowish, transparent. We now pour off the alcohol and add a strong solution of pure carmine in concentrated ammonia and a little glycerine, macerating them for about one day. Then we wash the staining liquid gradually off, first with water and then with alcohol, and preserve them in glycerine for examination.

Placing a male specimen (Fig. 4) on a glass slide under the dissecting microscope with low power, we now proceed with the dissecting needles to separate successively the different appendages, viz., the anterior long antennæ, the shorter posterior antennæ, the mandibles with palpus, the superior maxillipeds, the maxillæ, the inferior maxillipeds, the four pairs of natatory legs, the fifth, trans-

formed pair of legs, and finally the abdomen with the terminal furca. Viewing the remaining "carcass" from which those appendages have been taken, we will notice that there is a certain demarcation between head and thorax, forming a segment; following this we find five more thoracic segments, of which the fifth is half as long as either the second or third, the fourth slightly shorter than the second or third, which latter two are equally long, the first being somewhat longer.

In the female the first and fourth thoracic segments are longer than the second and third, the fifth is faintly sub-segmented on the dorsal side, laterally terminating in a strong spine similar to *Ichthyophorba denticornis* Claus (Opus citatum, p. 199, Tab. XXXV, Fig. 1).

We now place the glass slide under a compound microscope, applying a low magnifying power and inspect the left, normally shaped, anterior antenna (see Fig. 1).

It is beset with pretty large bristles, and consists of twenty-five joints. When connected with the body, the fifteenth joint will reach to the base of the abdomen, and the terminal bristles reach to near the tip of the furcal bristles. The anterior antennæ originate from the first pair of larval legs, and are the means with which the Diaptomus performs its peculiar jerking motions, described by Herrick in AMERICAN NATURALIST, 1879, page 622.

In glancing at the right antenna of the male (see Fig. 2) one would think it had been taken from an entirely different species—so dissimilar it looks! If we count the joints, we find but twenty-three, two joints less than in the left antenna. But either the tenth or twelfth joint must consist of two connate joints, and the twenty-first is evidently also sub-segmented, making in all, twenty-five joints. The sixteenth to the nineteenth joints, inclusive, are considerably dilated and swollen, enclosing a powerful muscle, inserted near the fifteenth and in the twentieth joint; thence follows the knee-shaped section of the antenna, the geniculating part, consisting of a larger joint with an inner duplicature or

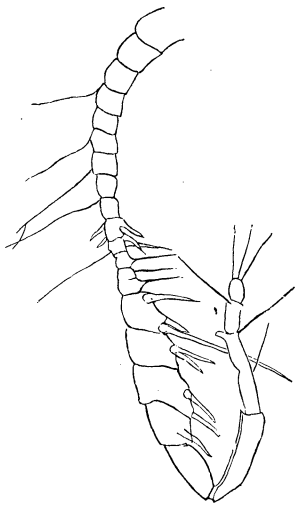

FIG. 2.—Right anterior antenna of male.

bead, forming a tier (originally several connate segments), and another larger, semi-segmented joint with a terminal, inner, bent-backward hook, and finally two smaller terminal joints. The dilated joints as well as some of the narrower preceding joints, are armed with powerful spines, and others with bristles. If this swollen right antenna be separated from a live male, it will twist around with snake-like motions for several minutes.

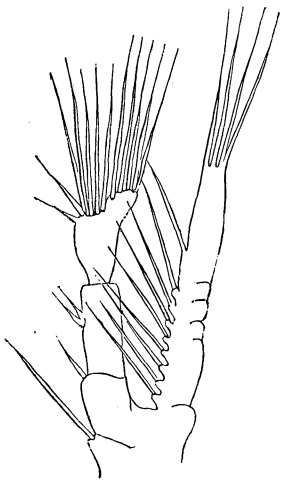

FIG. 3.—Posterior or second antenna. Main branch shorter.

As the external structures, with the exception of the fifth thoracic segment, the anterior antennæ, the fifth pair of legs and the abdomen, are alike in both sexes, we may proceed to the posterior or second pair of antennæ (see Fig. 3).

The posterior antennæ originate from the second pair of larval legs and have like those two branches. They are destined for locomotion, and also for respiration. The main branch is slightly shorter than the secondary branch.

Having once with certainty recognized the mandible (Fig. 4), then, after applying higher powers (about 500 ×), we are enabled to see the following characters: The tip of the first (outer) tooth is bent and has a very minute excavation. There are eight mandibular teeth. The second tooth is larger than any of the remaining six of the series, its suddenly contracted tip somewhat bent like the first tooth; it is separated from the third by an interval equal to the width of the tooth. A short stiff bristle appears at the lower end of the row of teeth. The secondary appendage of the mandibular palpus is four-jointed and bears six delicate bristles at its tip and inner margin. The larger, bent-upward bristle near the inner

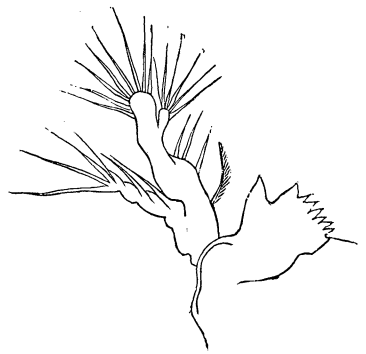

FIG. 4.—Mandible and mandibulary palpus. Enlarged about 300 ×.

base of the main mandibulary palpus is delicately bristled exteriorly only. Three smaller ciliæ are found above the latter on a small protuberance.

The mandible in all Copepoda originates from the third larval leg, which is already in the "Nauplius stage," provided with a dentate mandibular process. In the family of Calanidæ, the mandibulary palpus is comparatively longer than in the other five families of Copepoda.

The maxilla (Fig. 5) is quite a complicated structure, consisting of several lobes, the explanation of which is found below the cut. The maxillæ are the second pair of oral organs, and originate from the bristled and lobed appendages of the larva, and these occur behind the third natatory leg, or future mandibulary palpus.

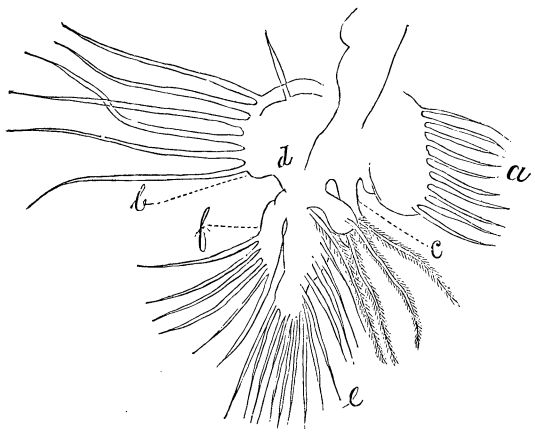

FIG. 5.—Maxilla. *a*, maxilla proper; *b*, basal broad lobe; *c* and *d*, two cylindrical basal processes; *e*, terminal palpus; *f*, posterior lobe, or secondary branch of palpus. Enlarged about 300 ×.

Another minute mouth-piece is the superior or first maxilliped (Fig. 6). It is somewhat sub-jointed, elongate, and bears fifteen bristles as the illustration shows. Both the superior and inferior maxillipeds are the separately diverging branches of a single pair of limbs originating out of the fifth pair of legs of the later "Nauplius stage," and are in the adult, with a few exceptions, dissimilarly inserted, the outer branches of those legs being transformed into the superior, the inner branches into the inferior maxillipeds.

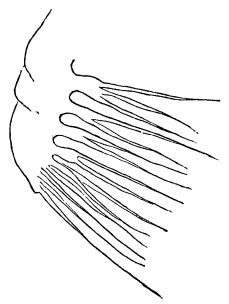

FIG. 6.—Superior or first maxilliped. Enlarged about 400 ×.

We now take a look at Fig. 7, representing the inferior or second maxilliped. Its basal segment presents in our species four rounded processes on

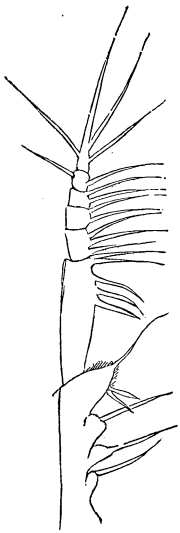

FIG. 7. — Inferior or second maxilliped.

its inner margin, the three first of which gradually become larger from base upwards, and bear each, one invaginate spine, the fourth is slightly produced inferiorly (the rounded tip being finely ciliate down to the produced lower middle), there (at the lower middle) bearing two spines directed downward, and a very fine long flagellum at its tip. The arrangement of the bristles of the last two joints, as well as the general outline of the whole, differ from *Diaptomus sanguineus* F.

The inner branch of the first of the four pairs of natatory legs has two, the rest three joints (see Fig. 8). Their purpose is aëration of the blood as well as locomotion.

The fifth pair of legs in the female is biramose, both branches arise from a two-jointed basal piece (coxa and trochanter), the inner branch is short, straight, slender, not jointed, abruptly terminating in a conical tip surrounded with microscopically small spines around a longer median one; at the side of the tip and opposing each other are two longer, movable (?) spines. The outer branch arises from the second broad basal joint, and is strong, two-jointed, terminating in a single, interiorly (near the tip) fine serrate claw, which has exteriorly two (one longer and one shorter) diverging spines a little above its middle (Fig. 9).

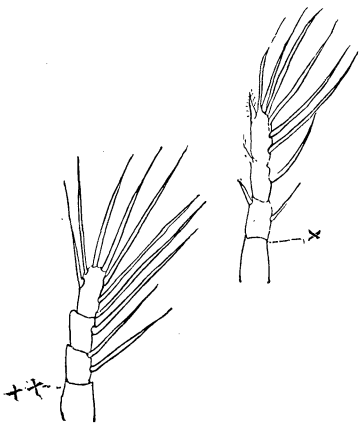

FIG. 8.—Form of second, third and fourth natatory legs. xx, inner branch; x, outer branch.

The office performed by the transformed fifth pair of legs in female individuals is not sufficiently known. They may be for the protection of the egg-sac or for properly placing the same, or perhaps they coöperate with the male in copulation. In some cases they may burst or pierce the spermatophores fastened below the female genital pore.

The fifth pair of legs in the male (Fig. 10) are very dissimilar. They both arise from a quadrate coxal joint; the left leg consists

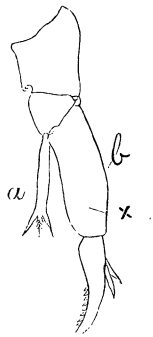

FIG. 9.—Fifth pair of legs of the female. *a*, inner, and *b*, outer branch.

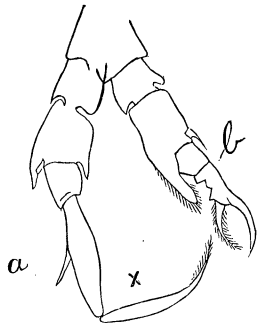

FIG. 10.—Fifth pair of legs of the male. *a*, right, and *b*, left leg.

of four joints, the first joint is quadrate and about one-third wider than long, slightly enlarging distally. The second joint is somewhat enlarged distally, about twice as large as the preceding joint, and bears a strong, wedge-shaped, blunt and finely serrate spine at the inner, and a shorter, slender one at the outer inferior angle. The third joint is clavate and distally tapering. The fourth joint is composed of an anteriorly notched, narrow basal piece exteriorly terminating with an incurved dactyl. The joint is from base to tip of dactyl, about two and a half times longer than the preceding joint; it terminates interiorly with another dactyl, nearly as long as the other; is finely serrate on both sides and acts in closing as a forceps. The right leg consists of five joints, the basal and the second joints are quadrate, the latter enlarges distally and bears a smaller blunt spine at the inner, and a larger one at the outer angle. The third joint is subquadrate, slightly tapering distally, the fourth joint is clavate, bearing a slender spine at the middle of its outer margin, and the fifth constitutes a slender incurved dactyl as long as the preceding joint, finely rugose on the distal half of its inner margin, and is so jointed as to close back against the inner margin of the fourth joint, which thus acts as a hand. The left leg (in Fig. 10, *b*, purposely drawn larger) reaches only about to the tip of the third joint of the right leg.

In the family of Calanidæ, in general, the abdominal segments are considerably narrower in the male than in the female, the former consisting of five, the latter of four segments. The first of

the five male abdominal segments is as long as the fifth, and is the broadest, its anterior ventral angle is prominent, the second joint is twice as long as the preceding, the third and fourth gradually shorter. Furca, from base to tip of bristles, longer than the first, second and third segments together.

The first of the four female abdominal segments bears ventrally an opening on a circular elevation (in Fig. 11, seen from the side), the female genital orifice, to which the secretion of a gluey mass, the product of two large orbicular cement glands, situated on the segmentation line between the fifth and sixth thoracic segments, flows. Mounted specimens plainly show the two ducts of the glands running down to the orifice in the first abdominal segment. The two ovarial lobes begin with broad rounded bases in the second thoracic segment, and gradually taper downward. Although I was unable to find the oviduct entering the first abdominal segment, it is evident, from the position of the egg-sac that the products of the cement gland and ovary have one and the same exit. A *receptaculum seminis* is wanting.

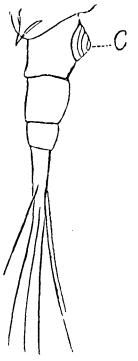

FIG. 11. — Side view of the four abdominal segments of the female. *c*, abdominal pore or genital orifice.

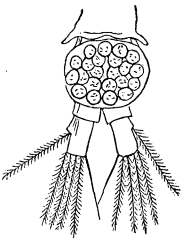

FIG. 13. — Front view of last thoracic segment below which, on the abdomen, is seen an egg-sac and the furca (the latter drawn larger in comparison with the rest).

The second segment is a little shorter than the first, the third is about half as long, the fourth is still shorter and bears the furca (Fig. 13), with orbicular egg-sac. From thirty to forty eggs are contained in a sac.

The spermatophores containing the fertilizing zoösperms are glued by the fifth pair of legs of the male to the female genital orifice during copulation. I noticed from one to four spermatophores on some females (Fig. 12).

The inaugural dissertation of Dr. Aug. Gruber, "Ueber zwei Süsswasser-Calaniden," Leipzig, 1878, pp. 34, two plates, gives us the latest knowledge concerning the formation and action of the spermatophores, and as this special work may not be in the hands of every American carcinologist, and owing to the complexity of the matter itself, an abstract of the same, I trust, will be welcome.

In the male the *vas deferens* can be distinguished into three distinct sections, each of them performing a different function. The glandular cells of the walls of the first section secrete a viscid, gluey substance, a sort of cement into which, coming from the testis and passing through the posterior terminus of the *vas deferens*, the elongate (in Diaptomus) zoösperms enter, forming a long narrow string. The diameter of the first section is nearly of equal width in its entire length. The second section is more dilated anteriorly, rounded and tapering posteriorly. Here we find a central, voluminously swelled mass, the above mentioned homogeneous glue-mass, peripherically surrounded with a layer of densely packed zoösperms, which but loosely fit into innumerable roundish lodges or hives, the latter constituting the interior of the partly perfected exterior spermatophore capsule. The formation of the latter began probably already in the first section, since the two sections do not functionally differ from each other. This still imperfect spermatophore enters immediately into the third and last section of the *vas deferens* as soon as the last perfect one has just left the male genital orifice.

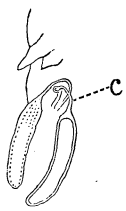

FIG. 12. — Front view of right angle of the last thoracic segment of female and part of the first abdominal segment with two spermatophores, *c*, one is partly and the other entirely empty.

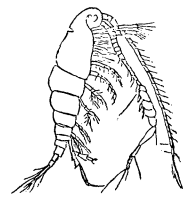

FIG. 14.—A male *Diaptomus sanguineus* var., enlarged about 8 times. Side view.

A number of zoösperms in the posterior rounded terminus of the spermatophore act as abortive or expelling factors, becoming first granulated toward the perfection of the spermatophore, and, through the endosmotic absorption of water, several of them coalesce with a number of cellular vesicles like soap-bubbles (polygonal in Diaptomus). The expelling cells gradually swell, pressing the central glue-mass into the middle of the spermatophore, and first become nucleate and then plain. Through the further increase of these expelling cells, the central glue-mass is more and more compressed and slowly moves toward and out of the narrow terminus of the spermatophore, and in oozing out forms a saussage-like body, by means of which, in copulation, the spermatophore is glued beneath the valvule of the female genital orifice. Into the center of this mass follows the remainder of the zoösperms, the latter being perfectly surrounded by the former, forming a

minute ball. The glue-mass, according to Dr. Gruber, evidently yields also the material for the formation of the egg-sac, since, firstly, in oozing out of the valvule the eggs are driven into the mass, and secondly, the egg-sac is not formed before the act of sexual union.

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SCOLOPENDRELLA AND ITS POSITION IN NATURE.

BY A. S. PACKARD, JR.

THE recent notices by Mr. John A. Ryder, particularly his last able paper,[1] have called fresh attention to this interesting creature, and his discovery of two species in addition to the one originally noticed by the writer, shows that the United States are as much favored as Europe in specific forms. Scolopendrella is a small, whitish tracheate animal, not exceeding a quarter of an inch in length, with a superficial resemblance to a myriopod, such as Scolopendra, having a pair of well developed, five-jointed legs to each abdominal as well as thoracic segment; its name ending in a diminutive gives evidence of the original opinion of its discoverer, that it was a small myriopod, like Scolopendra, the centipede. In deference to the general opinion of naturalists in our "Guide to the Study of Insects," and our "Zoölogy" we have let it remain among the Myriopods, but it occupied an uncertain place, as we waited for more light upon the subject of its affinities, and for time to study it with more care.

Attention was first called to the existence of this type of Tracheates in the New World by a brief notice which appeared in the Proceedings of the Boston Society of Natural History, Vol. XVI, p. 111, 1873, which read as follows:

"For nearly two years we have had in the Museum of the Peabody Academy of Science a specimen of Scolopendrella, detected September 8, by Mr. C. A. Walker, under a board in the grounds of the museum. It is nearly related to *Scolopendrella immaculata* Newport, and if new may be called *S. americana*. Of the remarkable features in the structure of this animal I do not now propose to speak. It has, however, in the head and antennæ a strong re-

[1] The structure, affinities and species of Scolopendrella, Proc. Acad. Nat. Sc. Phil., 1881, p. 79.